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The Effect of High Temperatures at Varying Stages of Growth on Kernel Production in Oats¹

By S. C. WIGGANS² and R. H. SHAW

Oats generally are considered to be less heat tolerant than other cereal crops. Coffman (1, 2) found that heat resistance in oats was correlated with winter hardiness, and that early maturing winter and spring varieties were usually more heat resistant than mid-season or late maturing varieties. Winter oat varieties with fine culms were the most heat resistant. Maximum resistance to killing injury occurred when the plants were about 50 days old, which corresponded to the early boot stage. Resistance to high temperatures was found to be an inherited character and was independent of disease resistance.

The present study was initiated to determine the effect of abnormally high temperatures, which may occur for short periods during the spring, on the production of mature oat kernels.

MATERIALS AND METHODS

During the winter of 1956-57 three varieties of oats, Andrew and Mo. 0-205, mid-season varieties, and Clintafe, a late variety, were grown in a greenhouse maintained at 70° F. ± 2° F. Three seeds of each variety were planted in 4-inch pots in soil containing 2 parts sandy loam, 1 part peat and 1 part sand. All pots were grown under a 14-hour photoperiod in which the natural daylight was supplemented with incandescent lights. As the plants of each variety reached certain stages of growth (3-leaf, 4-leaf, boot, etc.) they were placed in growth chambers 3' x 5' x 4' in size, illuminated by 4 fluorescent lights, two 20-watt daylight and two 20-watt white lights, and maintained at temperatures of 85° F., 90° F., 95° F. and 100° F., for either 4 or 8 hours per day for 7 days. After each series of treatments the pots were returned to the greenhouse bench and the oats allowed to mature. The number of caryopses (filled kernels) on the primary tiller of each plant was recorded at maturity. There were 12 plants of each variety per treatment in each of 3 tests conducted in 1956-57.

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During the winter of 1957-58 four oat varieties, Cherokee, an early, Clintland, a mid-season, Sauk, a late, and Victorgrain, a semi-winter type, were grown in each of two tests in the greenhouse. The light and temperature treatments were the same as in the previous year.

EXPERIMENTAL RESULTS AND DISCUSSION

The mean number of caryopses per plant at maturity for the 1956-57 tests are shown in Figure 1. The plants grown at high temperatures for 4 hours per day for 7 days had more than twice the number of caryopses per plant than those grown at high temperatures for 8 hours per day. The number of caryopses per plant increased when the treatments were made at the 5- instead of the 4-leaf stage. There was, however, a significant decrease in the number of caryopses produced at all temperatures for plants given an 8 hour per day high temperature treatment and for plants given the 100° F. treatment for 4 hours per day when treated at the 6-leaf stage of growth. Plants treated for 4 hours per day at 85° F., 90° F. and 95° F. did not decrease in the number of caryopses produced until treatment occurred at the boot stage. The fewest

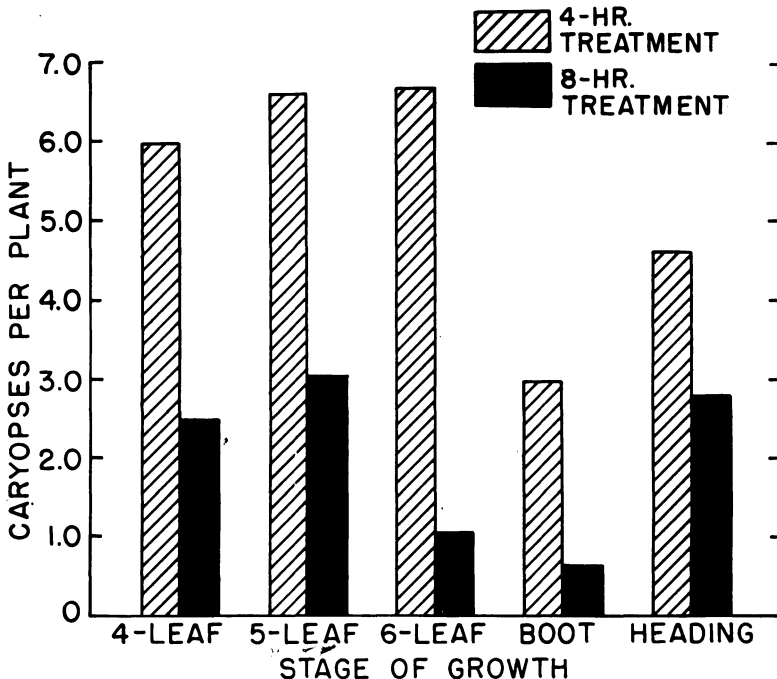


Figure 1. The mean number of filled kernels per mature oat plant when exposed to relatively high temperatures at varying stages of growth in 1956-57. (Averaged over 4 temperatures.)

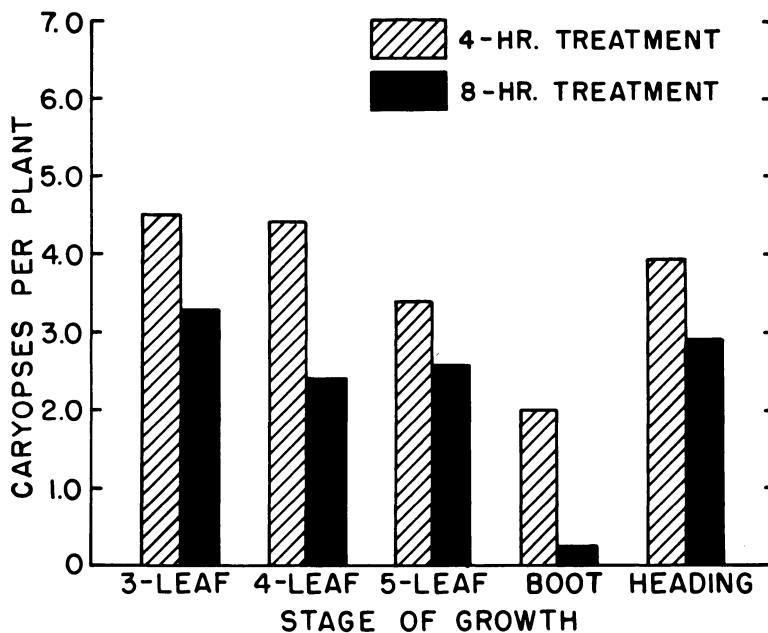


Figure 2. The mean number of filled kernels per mature oat plant when exposed to relatively high temperatures at varying stages of growth in 1957-58. (Averaged over 4 temperatures.)

caryopses per plant with both the 4 and 8 hour treatments were obtained when the oat plants were subjected to high temperature treatments during the boot stage, or approximately 42 days after planting. At this stage of growth floret initiation in the panicle branch occurs and the sporocytes are being differentiated (3). These results differ from those reported by Coffman (2) in which he found that maximum resistance to heat injury was obtained when the oats were in the boot stage of growth. However, he measured only the number of plants which survived severe heat treatments and not the number of caryopses obtained.

The data from the 1957-58 experiments are presented in Figure 2. The light, temperature and humidity conditions were essentially the same as in 1956-57 but fewer caryopses were produced per plant. These data essentially corroborate those obtained in 1956-57. The number of caryopses per plant was significantly greater for plants kept at high temperatures for only 4 hours per day, as compared with 8 hours. Plants treated at 100° F. for 4 hours per day showed a decrease in the number of caryopses produced at an earlier stage of growth (4-leaf stage) than those treated at lower temperatures (85° F. to 95° F.) for 4 hours per day. Again the number of caryopses per plant was less when the plants were subjected to

high temperatures at the boot stage than at any other stage of growth.

The number of caryopses per plant decreased as the length and temperature of the treatments were increased. In 1956-57 the mean number of caryopses produced per plant at the boot stage was 3.9 and 0.7, respectively, for plants subjected to 85° F. and 100° F. for 4 hours per day. Plants at the boot stage treated for 8 hours per day at temperatures of 85° F. and 100° F. produced, respectively, 1.6 and 0.2 caryopses per plant. The 1957-58 tests gave similar results.

Figure 3 shows the mean number of caryopses for each variety in 1957-58. Victorgrain, the semi-winter type, produced more caryopses than did the early or mid-season varieties. Coffman (2) also indicated that winter-type oats were most resistant to high temperatures. On the other hand, Sauk, a late oat, produced more caryopses per plant than did Cherokee or Clintland, early and mid-season oats, respectively. All varieties responded to high temperatures at different stages of growth in a similar manner. In all cases there

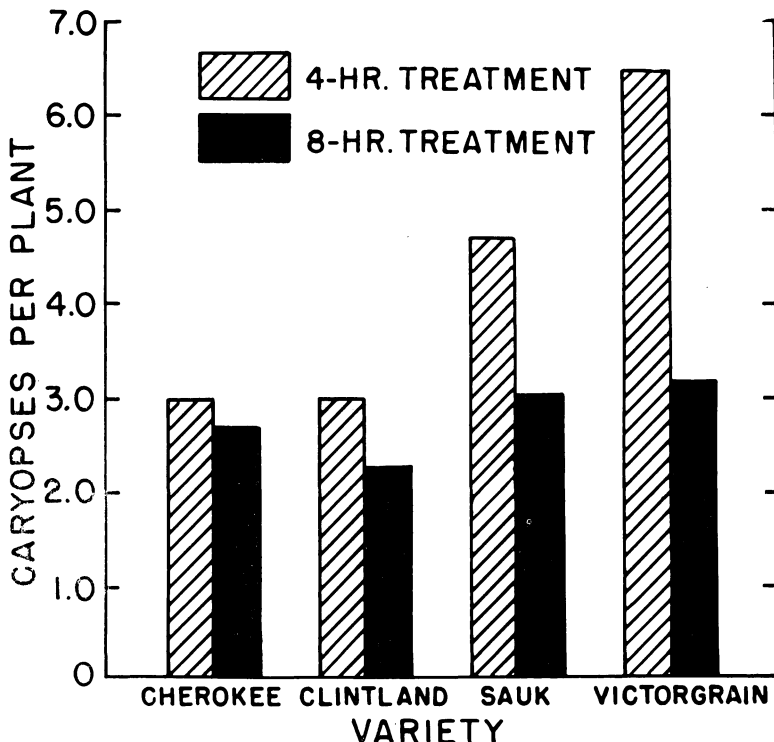


Figure 3. The mean number of filled kernels per mature oat plant for 4 varieties when exposed to relatively high temperatures in 1957-58. (Averaged over 4 temperatures and 5 stages of growth.)

was a significant increase in caryopsis production when the oat plants were exposed to high temperatures for 4 hours per day as compared to 8 hours.

SUMMARY

Several varieties of oats were grown in the greenhouse during the winter months of 1956-57 and 1957-58. Plants from each variety were placed in high temperature growth chambers at varying stages of growth for 4 or 8 hours per day for 7 days. The temperatures of the growth chambers ranged from 85° F. to 100° F. In general, the number of caryopses per plant increased as the stage of growth progressed until the boot stage, when there was a significant decrease in seed set and the fewest number of caryopses per plant were produced. Treatments subsequent to the boot stage again showed an increase in the number of caryopses per plant. The number of caryopses per plant was larger in the 4 hour than in the 8 hour high temperature treatments.

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